Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(2), 3699-3702 | ISSN:2251-6727

Minimally Invasive Approach for Vital Teeth Needing Root Canal Treatment- A Clinical Study

[1]Dr. Debkant Jena, [2]Dr. saloni choudhary, [3]Dr. Jaidupally Ramvilas Reddy, [4]Dr. Minal M Kshirsagar, [5]Dr. Suyog Savant, [6]Dr. Hitesh Ramdas Sawant,

[1]Professor, Department of conservative dentistry and endodontics, Kalinga Institute of dental sciences, KIIT university.

[2]senior lecturer, Krishnadevaraya College of dental sciences and hospital, Banglore (Corresponding author).

[3]MDS, Kliniq32 Dental Implant and Cosmetic centre, Hyderabad.

[4]Assistant Professor, Department of Public Health Dentistry, Bharati Vidyapeeth (Deemed to be) University Dental College and Hospital, Navi Mumbai.

[5]Associate professor and Head, Department of Public Health Dentistry, Bharati Vidyapeeth (Deemed to be) University Dental College and Hospital, Navi Mumbai.

[6]Assistant Professor, Department of Orthodontics and Dentofacial Orthopedics, Bharati Vidyapeeth (Deemed to be) University Dental College and Hospital, Navi Mumbai.

(Received: 07 January 2024 Revised: 12 February 2024 Accepted: 06 March 2024)

KEYWORDS
Smoking, Periodontal disease, Gingiva

ABSTRACT:

Aim:- The present study aimed to investigate the possible use of a non-instrumentation technique including blue light irradiation for root canal cleaning.

Methodology:- Seventy- five extracted human single rooted teeth were selected. Five different groups included NaOCl, NaOCl + EDTA irrigation after either instrumentation or non-instrumentation, and a blue light group following non-instrumentation technique. The antimicrobial efficacy of different preparation techniques was evaluated using microbial tests for S.mutan and E. faecalis species.

Results- The application of light could not provide antibacterial efficacy to match the NaOCl irrigation. The NaOCl irrigation both in the non-instrumentation and instrumentation groups significantly reduced the number of bacteria ($p < 0.05$).

Conclusion :- The use of minimally invasive root canal preparation techniques where the root canal is not instrumented and is disinfected by light followed by obturation may be an attractive treatment option for management of vital teeth needing root canal therapy.

INTRODUCTION

Root canal treatment is done to eliminate microorganisms and pathologic debris from the root canal system and to seal the root canal three dimensionally and to prevent any re-infection[1]. In 1974, Herbert Schielder mentioned few mechanical objectives of cleaning and shaping to promote the success of the root canal therapy. While doing root canal treatment, one should also make sure that there is no extensive loss of tooth structure during the process[2].

Minimally invasive endodontics treatment include preservation and maintaining physiological and defensive functions along with minimal removal of hard tissue which preserves structural integrity of tooth. Avoiding full pulpectomies which involves complete removal of the pulp to the apical constriction, wherever possible the biological response of immune system could be enhanced by even a partially retained pulp thus improving the treatment outcome and also helps in preventing further infection of the apical area[3].

Cleaning of the root canal system without instrumentation and the creation of a smear layer may be possible with non-instrumentation techniques. Several studies evaluated different non-instrumentation techniques and reported promising results[4-5]. However, all these studies used NaOCl irrigation in the non-instrumentation groups for the disinfection of the root canals, which, has numerous deleterious effects on root

Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(2), 3699-3702 | ISSN:2251-6727

canal dentin[6]. Therefore, a minimally invasive root canal cleaning technique that does not include instrumentation and chemical irrigation of the root canals is necessary.

The current study aim to present an antimicrobial approach to root canal decontamination using blue light in the spectrum of 400–470 nm which has been reported to have antibacterial effects against various pathogens[7]. Previous studies evaluated the antimicrobial efficacy of blue light and demonstrated that its application significantly eliminated endodontic pathogens such as *Enterococcus faecalis*, methicillin- resistant *Streptococcus aureus*, and *Prevotella intermedia*. The present study aimed to investigate the possible use of a non-instrumentation technique including blue light irradiation for root canal cleaning without instrumentation and chemical irrigation followed by obturation for the management of vital teeth requiring root canal therapy

MATERIAL AND METHOD

The present study was carried out in seventy-five extracted human single rooted teeth (Maxillary and mandibular anteriors and canines). Ethical approval was obtained from institutional ethical review board of the institute. The teeth were randomly distributed in five groups of 15 each. After the soft tissue and calculus remnants on the surface of the roots were removed mechanically using a scaler, the teeth were decoronated with a diamond disk to obtain a standardized root length of 15 mm since the average root length of single rooted teeth was reported within a range of 12.2–16.6 mm.

All the specimens were then embedded in dental impression putty. After the setting of the resin, the teeth were removed from the putty and longitudinally sectioned into two halves using low-speed saw. Then, the two halves of the sectioned teeth were realigned and wrapped by using Parafilm and finally placed into the previously numbered putty. The samples were divided into 5 groups (n = 15). The teeth with similar root sizes were distributed into the groups equally. The samples were preserved in a vacuum during the study.

Root canal therapy was undertaken using the standard root canal preparation and irrigation at a working length of 14 mm. The irrigation protocol was varied in the groups as follows:

NaOCl group: The root canals were irrigated with 1 mL of 5.25% NaOCl after every three pecking motions by using a side-vented irrigation needle. A total of 5 mL 5.25% NaOCl was used during the preparation. Then, the final irrigation was performed with 5 mL of 5.25% NaOCl for 3 min. A total of 10 mL 5.25% NaOCl was used.

NaOCl + EDTA group: The root canals were irrigated with 1 mL of 5.25% NaOCl after every three pecking motions by using a side-vented irrigation needle. A total of 5 mL 5.25% NaOCl was used during the preparation except the final irrigation with 5 mL of 5.25% NaOCl was followed by 5 mL of 17%EDTA irrigation for 3 min**.** Another 2 groups were formed as the non-instrumentation groups. The non-instrumentation groups excluded the use of the reciprocating files and used the same irrigation protocol as the instrumentation groups.

Blue light group- the light was applied from both the inside the root canal and outside the root canal. Before the application of the light, the root canal was filled with 0.1 mL of distilled water. For the application of the light outside the root canal, a 105 µm fibre was used. The light was applied from the access of the root canal for 5 min. Finally, the root canals were irrigated with 10 mL of distilled water by using a side-vented irrigation needle.

E. faecalis ATCC 29212 and *Streptococcus mutans* (*S. mutans)* 3209 were used for microbiological experiments. Overnight cultures were prepared by inoculating 3 colonies of either *E. faecalis* or *S. mutans* into 5 mL of BHI broth each and incubated in the shaking incubator as described earlier. After the incubation, the optical density at 600 nm (OD600) was measured. Then, the overnight cultures were diluted using BHI broth to obtain 4 different suspensions for each species (*E. faecalis* and *S. mutans*) with an OD600 of 1.063, 0.744, 0.496, and 0.265 for *E. faecalis*, and an OD600 of 1.039, 0.528, 0.302, and 0.174 for *S. mutans.* These dilutions were then used to plate CFUs. This allowed a correlation between optical density and CFUs.

Two hundred microliters (µL) of the solutions were added into wells of a 96-well plate and tenfold serial dilutions in phosphate-buffered saline (PBS) were performed, Then, 20 µL aliquots of the cultures were plated on BHI agar plates, they were incubated at 37 °C for 24 h and the CFUs were counted. For the inoculation of the root canals, 108 CFUs/mL bacteria were used which equals an OD600 of 0.23 for *E. faecalis* and 0.06 for *S. mutans*

Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(2), 3699-3702 | ISSN:2251-6727

RESULT

The median and min–max bacterial counts of *E. faecalis* and *S. mutans* species according to the groups.(Table1,2).

Table 1:- The median and min–max bacterial counts of *E. faecalis* species according to the groups

	Median	Min-Max	p-value
NaOCl with instrumentation	0	0	
NaOCl+EDTA with instrumentation	0	0	
NaOCl without instrumentation	0	0	
NaOCl+EDTA without instrumentation	4.8	1-17	0.471
Blue light	$3.1x10^3$	$2.4x10^3$-$5.2x10^3$	

Kruskul-Wallis test, not significant

Table 2:- The median and min–max bacterial counts of *S. mutans* species according to the groups

	Median	Min-Max	p-value
NaOCl with instrumentation	0	0	
NaOCl+EDTA with instrumentation	0	0	
NaOCl without instrumentation	4.5	1-23	
NaOCl+EDTA without instrumentation	0	0	0.243
Blue light	$2.2x10^2$	$1.4x10^2$-$3.5x10^3$	

Kruskul-Wallis test, not significant

According to the results, light group failed to reduce the bacterial load significantly for both *E. faecalis* and *S. mutans* ($p > 0.05$). However, NaOCl irrigation both in the non-instrumentation and instrumentation groups significantly reduced the number of CFUs proving the strong antibacterial efficacy of NaOCl in this experimental model. Interestingly, there was no statistically significant difference between the light and NaOCl groups in terms of the number of CFUs, demonstrating that instrumentation is also an important factor in the removal of bacteria from the root canal system and can provide similar results to NaOCl irrigation.

DISCUSSION

In the present study, different instrumentation and irrigation protocols were tested to evaluate their effects on root canal therapy and to compare their antimicrobial efficacy.

The light application did not damage the root canal dentin as indicated by the scanning electron microscopy showing unchanged microstructure[8]. In contrast, instrumentation or NaOCl irrigation protocols damaged the root canal dentin and changed its original morphology. NaOCl irrigation caused a smear layer formation irrespective of the instrumentation protocol and showed an irreversible destructive effect on mineralized dentin. This finding was expected as the NaOCl has a proven organic matter dissolving ability and was capable of removing the organic phase from the superficial subsurface of mineralized dentin which resulted in the deterioration of predentin[9-10]. It is well known that the mineralized dentin is protected from thermal denaturation and enzymatic degradation by apatite crystallites within the interfibrillar and intrafibrillar spaces of the collagen matrix[11-12]. Furthermore, the NaOCl affects not only the organic phase but also the inorganic parts of the root canal dentin[13].

The study findings revealed that light application could not obtain complete elimination of bacteria inside the root canal as there was no statistically significant difference between the light and other groups neither in the *E. faecalis* nor the *S. mutans* inoculated samples. It is well known that the antimicrobial action of blue light is dose-dependent and increases with the exposure time

According to the result of the present study, NaOCl irrigation significantly reduced the number of CFUs inside the root canal both in the instrumentation and non-instrumentation groups. This finding has proved the strong antibacterial efficacy of NaOCl which is in

Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(2), 3699-3702 | ISSN:2251-6727

accordance with previous results[14]. Interestingly, the instrumentation and distilled water irrigation protocol also removed bacteria from the root canal space effectively which demonstrates that instrumentation is also an important factor in the removal of bacteria from the root canal system and can provide similar results to the NaOCl irrigation. In accordance with this result, Bystrom et al[15]. reported that mechanical instrumentation with saline irrigation can reduce the number of bacteria considerably. Thus, it can be asserted that instrumentation causes mechanical disruption of biofilms inside the root canal systems and accompanying distilled water irrigation flushes away the disrupted biofilms from the root canal space.

CONCLUSION

Instrumentation and NaOCl irrigation have detrimental effects on the chemical structure of dentin. Minimally invasive root canal preparation techniques where the root canal is not instrumented and is disinfected by light irradiation followed by obturation is a treatment option for management of vital teeth needing root canal therapy. Blue light is a promising tool due to its easy use and antibacterial features.

Using blue light for root canal preparation should be further evaluated in prospective clinical studies.

REFRENCES

1. Nair PR. Pathogenesis of apical periodontitis and the causes of endodontic failures. Crit Rev Oral Biol Med. 2004 Nov;15(6):348-81.
2. Jenarthanan S, Subbarao C. Comparative evaluation of the efficacy of diclofenac sodium administered using different delivery routes in the management of endodontic pain: A randomized controlled clinical trial. J Conserv Dent. 2018 May-Jun;21(3):297-301.
3. Malli Sureshbabu N, Selvarasu K, V JK, Nandakumar M, Selvam D. Concentrated Growth Factors as an Ingenious Biomaterial in Regeneration of Bony Defects after Periapical Surgery: A Report of Two Cases. Case Rep Dent. 2019 Jan 22;2019:7046203.
4. Ordinola-Zapata, R. *et al.* In vitro efficacy of a non-instrumentation technique to remove intracanal multispecies biofilm. *Int. Endod. J.* **55**, 495–504 (2022).
5. Attin, T., Buchalla, W., Zirkel, C. & Lussi, A. Clinical evaluation of the cleansing properties of the noninstrumental technique for cleaning root canals. *Int. Endod. J.* **35**, 929–933 (2002).
6. Rath, P. P., Yiu, C. K. Y., Matinlinna, J. P., Kishen, A. & Neelakantan, P. The effect of root canal irrigants on dentin: A focused review. *Restor. Dent. Endod.* **45**, e39 (2020).
7. Zhang, L. *et al.* Antimicrobial activity of an implantable wireless blue light-emitting diode against root canal biofilm in vitro. *Photobiomodulation Photomed. Laser Surg.* **38**, 694–702 (2020).
8. Hulsmann, M. Effects of mechanical instrumentation and chemical irrigation on the root canal dentin and surrounding tissues. *Endod. Top.* **29**, 55–86 (2013).
9. Craig-Baumgartner, J. & Mader, C. L. A scanning electron microscopic evaluation of four root canal irrigation regimens. *J. Endod.* **13**, 147–157 (1987).
10. Zhang, K. *et al.* The effect of initial irrigation with two different sodium hypochlorite concentrations on the erosion of instrumented radicular dentin. *Dent. Mater.* **26**, 514–523 (2010).
11. Armstrong, S. R., Jessop, J. L. P., Winn, E., Tay, F. R. & Pashley, D. H. Denaturation temperatures of dentin matrices. I. Effect of demineralization and dehydration. *J. Endod.* **32**, 638–641 (2006).
12. Carrilho, M. R. *et al.* Host-derived loss of dentin matrix stiffness associated with solubilization of collagen. *J. Biomed. Mater. Res. Part B Appl. Biomater.* **90B**, 373–380 (2009).
13. Tartari, T. *et al.* Tissue dissolution and modifications in dentin composition by different sodium hypochlorite concentrations. *J. Appl. Oral Sci.* **24**, 291 (2016).
14. Ruksakiet, K. *et al.* Antimicrobial efficacy of chlorhexidine and sodium hypochlorite in root canal disinfection: A systematic review and meta-analysis of randomized controlled trials. *J. Endod.* **46**, 1032-1041.e7 (2020).
15. Bystrom, A. & Sundqvist, G. Bacteriologic evaluation of the efficacy of mechanical root canal instrumentation in endodontic therapy. *Scand. J. Dent. Res.* **89**, 321–328 (1981).